Impact of Knowledge Transfer Through the Implementation of an Emergency Telemedicine Program in a Brazilian Community Hospital

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***Abstract* — Variation of quality care has been associated with heterogeneous survival rates among emergency and critical care patients. A body of evidence has shown that emergency and ICU physician-led team could deliver a more adequate care and decrease mortality rates and costs. In developing countries there is a shortage of specialists even in metropolitan areas. The main objective of this study is to describe the first Brazilian experience of a real time audio-visual telemedicine program (TM) providing 24/7 emergency and Intensive Care physicians' coverage. Methods: The concept of telemedicine was implemented at two different hospitals in São Paulo; a secondary and public hospital, Hospital Municipal Moyses Deutsch (HMMD), and a tertiary and private hospital, Hospital Israelita Albert Einstein (HIAE). Results: Data were obtained from 100 teleconsultations (85 patients) records over a 4 months period. The majority of the requests originated from ICU (74.1%). Sepsis was the most common reason to access TM (29.4%), followed by stroke (24.7%). TM improved diagnosis in 16.5% and influenced clinical management in 83.5% of the patients. Life-saving TM interventions were stroke thrombolysis in 4 patients and a limb amputation in 1 patient. The majority of patients was discharged with no necessity of referring to another hospital. Conclusion: We conclude that the main contribution of telemedicine-based intervention is to avoid unnecessary transfers and to improve medical decision-making in a real time fashion.**

Keywords-Telemedicine; Emergency care; TeleICU.

I. INTRODUCTION

Brazil is a federative republic that covers 8·5 million km^2 or 47% of the South America continent. With an estimated population of 190,732,694 in 2010, Brazil is the world's fifth most populous country around the world [1]. The Brazilian health system is made up of a complex network of complementary and competitive service providers and purchasers, building a public—private mix that is funded mainly by private institutions. The health system has three subsectors: the public subsector, in which services are funded and provided by the state at the federal, state, and municipal levels, including military health services; the private (for-profit and non-profit) subsector, in which services are funded by public and/or private institutions; and the private health insurance subsector, with different forms of health plans, varying insurance premiums, and tax subsidies. The public and private components of the system are distinct but interconnected [2, 3].

Brazilian "universal" healthcare system is called the Sistema Unico de Saude (Unified Health System, SUS). Most of the population (75%) utilizes almost exclusively this system, which sometimes is unable to offer a qualified health care to all of them. In fact, there is a shortage of doctors and nurses, especially in rural and even in distant metropolitan areas. Many hospitals are also poorly managed, lacking autonomy from state governing boards. And finally, there is a high level of inequality in medical technology and infrastructure, with larger, more affluent municipalities able to provide better technological equipment and medical care [3].

Survival rates for emergency care vary significantly between hospitals, reflecting variations in the quality of care. Many hospitals do not have the facilities and skills to provide effective specialist treatment, 24 hours a day, seven days a week. Evidence shows that emergency and ICU care should be led by experienced consultants with quicker and better decision-making processes, especially in the care of major trauma, sepsis, stroke and acute myocardial infarction [4,5].

Within this scenario comes up seeking to develop options for solving the health problems of critically ill patients, using effective remedies in the quality of care provided. In this context, appears telemedicine as a viable alternative to efficient resolution of such problems. The World Health Organization (WHO) [6] defines telemedicine as "the offering services related to health care, where the distance is a critical factor. Such services are provided by qualified health professionals, using information technology and communication to exchanging knowledge and information valid for diagnosis, prevention and treatment of diseases, and the continuing education of health care providers with health, as well as for scientific research purposes [6]. The Health Department, in order to improve the Public Health System, has decided to create the PROADI - Projeto de

 ISBN: 978-1-61208-252-3

Apoio ao Desenvolvimento Institucional ao SUS, to improve health services around the country. The PROADI allows some hospitals, classified as "excellent" in terms of quality of care, fund projects, by using philanthropy. In this scenario, the HIAE developed a telemedicine program allowed emergency department and ICU staffs from public hospitals, including the Hospital Moyses Deutsch (HMMD), to receive real-time support from specialist staff in the emergency department and ICU at the Hospital Albert Einstein (HAE).

The HMMD is a 240-beds, medium-complexity, public general hospital, including 60 emergency department beds. An estimated 500,000 people live near to the hospital. Emergency Department receives an annual volume around 200,000 visits. Clinical, pediatrics, surgical, orthopedics, gynecology and obstetrics services are offered. HMMD is located at Jardim Angela district and cover an area with more than 23,125 square, at one of the most deprived areas in São Paulo city that has been considered by the United Nations as one of the most violent urban region in the world.

The objective of this paper is to describe the impact of first Brazilian, real time telemedicine program (TM) providing 24/7 hours/days of an emergency department (ED) and Intensive Care Unit (ICU) coverage. This article is organized as follows: Section 2 presents the methodology and the parameters evaluated. Section 3 shows the most important results. Section 4 deals with discussions. Finally, Section 5 which presents the conclusions and future work.

II. METHODS

In January 2012, the concept of telemedicine (synchronous connection) was implemented between HIAE and HMMD. We implemented a Telemedicine Central Command (TCC) located at HIAE with Endpoint 97 MXP Cisco ® Solution via a dedicated broadband connection of 2 Mb. TCC offers 24/7 coverage provided of ED and ICU consultant and a full range of services and specialties in house, including neurologists, cardiologists and radiologists. We recruited 16 physicians dedicated to TM program with the following characteristics: owning motivation and pro-activity to participate in the project; ICU or ED specialized; ability to transpose the difficulties and propose solutions and mastering all service protocols offering support to applicants.

In the remote hospital (HMMD), a mobile Intern MXP ISDN/IP Cisco ® was introduced. The wireless network was sized to ensure quality signal transmission environment throughout the Emergency department and Intensive Care Unit (ICU). Radiologic and CT scans exams were evaluated using PACS technology.

Inclusion criteria to access Telemedicine were based upon remote ICU or ED physician judgment. Every recruited patient, irrespective of whether transferred or not, was assessed by the Central Command through teleconference with an experienced consultant. Furthermore, we developed 36 clinical protocols that cover broader range of medical entities commonly encountered at the ICU and ED.

Routine data extracted from electronic forms were patient demographics, source of referral, further details of presenting complaint and diagnosis, examinations performed, throughput times, treatment (s) given and discharge categories. Case specific data were collected during teleconsultation. including patient ID; names and grades of staff requesting and providing consultations; presenting complaint; date and time of consultation; type of consultation and images discussed; reason for consultation and query to be resolved; time taken and resources used; nature and impact of any technical problems; diagnosis; referral or treatment advice given.

III. RESULTS

From May to October 2012, a total of 100 patients records from 85 patients were analyzed. Mean age was 48.5 yo, 51 (60%) were male, mean APACHE II SCORE was 22.3; 63 (74.1%) patients were at ICU and 22 (25.9%) were at the ED. The main diagnoses are described in Table 1.

TABLE 1.PATIENTS DIAGNOSES

Diagnoses	n	%
Neurologic *Stroke. Trauma. Syncope.*	27	31.8%
Infection / Sepsis	25	29.4%
Cardiac / Pulmonary *Cardiac Arrest. Infarction. Heart Failure. Heart Block. Pericarditis. Tamponade. Pulmonary Embolism. Lung Cancer.*	20	23.7%
Abdominal *Mesenteric Ischemia. Pancreatitis. Hepatic Failure.*	5	5.9%
Trauma *Abdominal. Thoracic. Hemorrhagic Shock.*	4	4.8%
Others *Coagulopathy. Hyperosmolar Syndrome. Intoxication.*	4	4.8%

 ISBN: 978-1-61208-252-3

For 14 patients (16.5%), TCC influenced diagnosis conclusion, and for 71 patients (83.5%), TCC contributed to clinical management. In 53 (62.4%) of the consultations, a specialist other than TCC staff were needed to attend specific requests. The external medical specialists consulted are summarized in Table 2.

TABLE 2. SPECIALISTS DEMANDED

Medical Specialist	N	%
Neurology	23	43.4%
Pneumology	6	11.3%
Cardiology	6	11.3%
Infectology	4	7.5%
Gastroenterology	3	5.7%
Cardiac Surgery	2	3.8%
General Surgery	2	3.8%
Hematology	2	3.8%
Others	5	9,5%

Most of the teleconferences occurred in the middle of the day, around 1:30 PM (Table 3). The mean hospital length of stay was 13.6 days, the hospital mortality was 37.6% (32 patients). Regarding patients admitted at the ED (22), 15 (68.2%) were transferred to the ICU, 10 (11.7%) were transferred to a tertiary hospital and 6 of these patients (7.1%) were submitted to major surgical procedures [heart surgery (2), neurosurgery (3) and liver transplantation (1)]. Among all the 85 patients, 36 (42.4%) had an invasive or surgical procedure indicated after TM session.

TABLE 3: TIME OF TM CONSULTATION

Time	Cases
Morning	24
Afternoon	70
Night	6

Table 4 describes the main procedures performed after TM consultation. In 19 (22.4%) patients TM suggested antibacterial-changing scheme.

Among the 4 patients submitted to stroke thrombolysis, the mean time from the onset of the symptoms to the initial of the procedure was 163.2 min, mean NIH Stroke Scale was 14.7 before the thrombolysis and 12.7 at the end of the procedure. There were no cases of bleeding complications after the procedure.

TABLE 4. INVASIVE / SURGICAL PROCEDURES

Diagnosis	n	%
Hemodialysis	17	47,2%
Coronary Angiography	4	11,1%
Stroke Thrombolysis	4	11,1%
Neurosurgery	3	8,3%
Angiography	2	5,5%
Chest Tube Placement	2	5,5%
Cardiac Surgery	2	5,5%
Limb Amputation	1	2,7%
Liver transplantation	1	2,7%

IV. DISCUSSION

Telehealth technologies, which embrace telemedicine, are being used in a wide array of applications and environments, and there is a substantial body of literature advocating their use and general utility [7,8].

Telemedicine has the potential to improve quality of care by allowing clinicians in one “control center” to monitor, consult and even care for and perform procedures on patients in multiple locations.

TM experience in other medical specialties fully applies in the field of emergency medicine (EM) [9,10]. Emergency healthcare is complex but its most important requirement is rapid and correct decision-making on diagnosis and treatment. In addition, this occasionally must be performed in situations other than in a hospital emergency department (ED). Thus in the case of accidents, emergencies, and so on, healthcare is necessary in poor conditions and, most importantly, away from the reference health center, so that distance and time factors get great relevance for the successful diagnosis and treatment of affected patients. In this context, remote teleconsultation by specialists in an emergency situation may be important for rapid, correct and specialized decision making, whether clinical or surgical, on immediate questions such as whether and where to transfer the patient or what therapy should be administered.

Telemedicine may provide medical decision support for remote practitioners with the effect of reducing inter-hospital transfers and improving quality of care. By enabling the transmission of visual information such as X-rays or pictures of injuries to specialists, telemedicine may enable remote practitioners to obtain expert guidance on how to manage a patient locally.

Quality health care to critical patients is complex and requires extensive resource use; the shortage of qualified experienced multidisciplinary teams in some public

 ISBN: 978-1-61208-252-3

Brazilian Hospitals can negatively affect the outcomes of critical patients. Otherwise, the primary and secondary hospitals need to transfer the critical patients to tertiary centers, which increase the costs of Health System.

Tele-ICU programs can be a solution because they are capable of leveraging the skills of an experienced team of critical care doctors and nurses to ICUs where bedside services are not available and provide a vehicle for broadly applying evidence-based best practice protocols to improve patient safety and outcomes [9]. The experience led us to develop evidence-based protocols but tailored to local constraints such as use of thrombolytics in cases of acute myocardial infarction when angioplasty is not available. We´ve made up to 36 protocols regarding most common ICU and ED issues. These protocols were also used to initiate telemedicine sessions.

Although some patients may still require transfer or referral, particularly in the absence of the necessary on-site facilities or expertise, telemedicine should ensure transfers are appropriate, and made to the right specialist at the right time. It may also ensure that both patients and the receiving unit are adequately prepared for the transfer. Even in cases where a transfer may not be indicated, telemedicine may be used as a medium for 'second opinions' on diagnosis and management, providing reassurance to both the clinician and the patient prior to discharge and potentially improving quality of care. In this case, patients may actually receive an enhanced service, in that they may receive a more senior opinion, other way this would not be feasible.

Advantages related to the implementation of telemedicine in the ED and ICU other than the availability of an experienced team readily accessible, include: to obtaining conducting videoconferencing between stakeholders; quick access to updated sources of information for conducting research together, including development of scientific protocols. Allows patients have access to specialist services including for case discussion and opinion of experts, the viability of training and standardization of procedures and better quality of care, more efficient monitoring of critical patients, as well as monitoring and efficient management of quality indicators of ED and ICU departments.

The benefits also include greater patient safety, reduction in the hospital costs; reduction in the number of hours / ICU nurse / patient-day, reduction in costs for pharmacy, laboratory supplies, therapies and other costs associated with the care of ICU patients. Beyond addition, by promoting the reduction of mean length of stay enables increase in the volume of admissions that result in an increase in revenue institutions. Some authors reported reductions in hospital and ICU length of stay and hospital mortality as well [11].

In Brazil, as in other countries, there is a lack of specialized professionals (including for intensive care), few Brazilian ICUs have specialized physicians 24 hours available. The reasons for this shortage are the high cost of hiring skilled labor and lack of specialized intensive care physicians. Telemedicine programs can help meet this demand by professionals, since they allow access to centers reference in critical care medicine to several distant hospitals, providing this expertise remotely, enabling other professionals, contributing with the reduction of morbidity and mortality. The Hospital Municipal Dr. Moyses Deutsch is a secondary hospital located at a very poor and populated district of São Paulo – Brazil. There is a monthly average of 16000 visits at the ED; many of these are admitted at the hospital with very bad social and health conditions, contributing unfavorably to the patient's outcomes. The clinician's hospital staff is compounded by young general doctors, without specialists like neurologists, neurosurgeons, cardiologists and many others. In this scenario it has been always necessary to transfer many patients to tertiary hospitals to be seen by specialists. Before the implementation of the Telemedicine Program as many as 60 outside evaluations were made each month, mainly for neurologic evaluation. The implementation of the Telemedicine Program reduced unnecessary transfers, during the 6 month period of initial experience; only 11.7% (10 patients) were transferred to other medical centers.

As mentioned before, HIAE provide in house coverage of experienced neurologists available 24/7 hours/days. Through PACS system and radiologist support, TM offered decision making support for stroke thrombolysis. Before the implementation of the TM program, this therapy has never been applied. This is the first Brazilian experience with the implementation of a TM program and the first report of successful stroke thrombolysis guided by telemedicine.

Financial cost also poses both a real and perceived barrier to the application and adoption of telemedicine in developing countries. Equipment, transport, maintenance, and training costs of local staff can be daunting for countries with little income or limited funding for the implementation and maintenance of telemedicine initiatives. Moreover, convincing evidence to support the overall cost-effectiveness of particular telemedicine strategies may be weak, while the economic implications of such strategies in different settings may not yet be known [8,11].

If telehealth is going to move beyond being regarded by many as a tool or a substitute for traditional healthcare delivery, its ability to impact diagnosis, treatment options and patient outcomes must be demonstrated using experimentally rigorous techniques supported by appropriate statistics.

This is a retrospective observational study that analyzed the initial Brazilian experience in the implementation of a Telemedicine Program connecting a secondary medium complex regional public hospital to a tertiary medical center.

The study presented initial encouraging results, the program proved to be useful in helping diagnosis, conducting critical cases and transferring specialized medical knowledge to hospitals with shortage of human and technical resources.

 ISBN: 978-1-61208-252-3

V. CONCLUSION AND FUTURE WORK

We conclude that the main contribution of telemedicine-based interventions from the tertiary to the secondary hospital is to avoid unnecessary transfers and to improve medical decision-making in real time by an effective expertise transfer. Besides, the implementation of this program allows patients with stroke timely receive thrombolysis guided by telemedicine. Finally, a prospective clinical trial will be running to analyze the impact of TM program on patient outcomes, including hospital length of stay, sequelae, and hospital mortality. From these data, we could spread this technology in different areas around the country.

ACKNOWLEDGMENT

Coordenação Geral de Atenção Hospitalar
CGHOSP/DAE/SAS/MS- Brazilian Ministry of Health

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 ISBN: 978-1-61208-252-3